**Decision Rationale**

**Total Maximum Daily Load for**
**the Aquatic Life Use Impairment on Stroubles Creek**

## I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDL for the aquatic life use (benthic) impairment on Stroubles Creek. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a margin of safety.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

## II. Background

The Stroubles Creek watershed is located in Montgomery County, Virginia. The watershed is approximately 6,119-acres in size. The impaired segment of Stroubles Creek begins at the headwaters of the Central Branch of Stroubles Creek and terminates at its confluence with Walls Branch. The watershed is located within the Town of Blacksburg and parts of the stream flow through the campus of the Virginia Polytechnic Institute (Virginia Tech). Therefore, a large portion of the watershed would be characterized as containing urban lands. Urban lands make up 47 percent of the 6,119-acre watershed, the remaining watershed is composed of agricultural (26%) and forested (27%) lands.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality

(VADEQ) listed 4.87 miles of Stroubles Creek (VAW-N22R) on Virginia's 1998 Section 303(d) list as being unable to attain the general standard for the aquatic life use. The impaired segment length was increased to 4.98 miles on Virginia's 2002 Section 303(d) list. A bacteriological (fecal coliform) impairment was also added to the segment in 2002. The bacteriological impairment is 7.03 miles in length and is not addressed as part of this TMDL. The failure to attain the general standard for the aquatic life use was determined through biological assessments of the benthic macroinvertebrate community. This decision rationale will address the TMDL for the impairment of the aquatic life use.

Virginia's 305(b)/303(d) guidance states that support of the aquatic life beneficial use is determined by the assessment of conventional pollutants (dissolved oxygen, pH, and temperature); toxic pollutants in the water column, fish tissue, and sediments; and biological evaluation of benthic community data.[1] Therefore, a biological assessment of the benthic community can be used to determine a stream's compliance with the state's general standard for the aquatic life use. Virginia uses EPA's Rapid Bioassessment Protocol II (RBPII) to determine status of a stream's benthic macroinvertebrate community.[2] This approach evaluates the benthic macroinvertebrate community between a monitoring site and its reference station. Measurements of the benthic community, called metrics, are used to identify differences between monitored and reference stations.[3] Please note that the state is currently in the process of changing this methodology to a stream condition index (SCI) approach.

As part of the RBPII approach, reference stations are established on streams which are minimally impacted by humans and have a healthy benthic community. These reference stations represent the desired community for the monitored sites. Monitored sites are evaluated as non-impaired, slightly impaired, moderately impaired, or severely impaired based on a comparison of the biological community of the reference and monitored sites. Streams that are classified as moderately (after a confirmatory assessment) or severely impaired after an RBPII evaluation are classified as impaired and are placed on the Section 303(d) list of impaired waters. During the 1998 assessment period, Stroubles Creek was identified as being moderately impaired. Stroubles Creek continues to be assessed using RBPII. The RBPII scores for Stroubles Creek have improved so that it would now be classified as slightly impaired.

RBPII assesses the health of the macroinvertebrate community of a stream. The analysis will inform the biologist if the stream's benthic community is impaired. However, it will not inform the

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[1]VADEQ. 1997. 1998 Water Quality Assessment Guidance for 305(b) Water Quality Report and 303(d) TMDL Priority List Report. Richmond, VA.

[2]Tetra Tech 2002. Total Maximum Daily Load (TMDL) Development for Blacks Run and Cooks Creek. Fairfax, Virginia.

[3]Ibid 2

biologist as to what is causing the degradation of the benthic community. Additional analysis is required to determine the pollutants which are causing the impairment. TMDL development requires the identification of impairment causes and the establishment of numeric endpoints that will allow for the attainment of designated uses and water quality criteria.[4] A reference watershed approach was used to determine the endpoints for the Stroubles Creek TMDL. Numeric endpoints represent the water quality goals that are to be achieved through the implementation of the TMDL which will allow Stroubles Creek to attain its designated uses. A reference watershed approach is based on selecting a non-impaired watershed that shares similar land use, ecoregion, and geomorphological characteristics with the impaired watershed. The stream conditions and loadings in the reference stream are assumed to be the conditions needed for the impaired stream to attain standards.

To determine whether a stream was a suitable reference site for the impaired water, the modelers evaluated the topography, soils, ecoregion, land uses, watershed size, and point source inventory of the potential reference site. All reference site candidates were evaluated as unimpaired in the biomonitoring analysis. It should be noted that there were no potential reference sites (unimpaired streams) with an urban land use as large as what is seen on Stroubles Creek. The reference site selected for Stroubles Creek was Toms Creek. Toms Creek was the reference stream for Stroubles Creek in the RBPII analysis. Toms Creek is evaluated as unimpaired when using the proposed SCI approach as well.

The next step in the TMDL development process was to determine the loadings and stressors in the monitored and reference watersheds. Low dissolved oxygen (DO), sedimentation, habitat modification, nutrients, and toxic pollutants were evaluated as possible stressors to Stroubles Creek. Ambient water quality monitoring (AWQM) on the streams documented temperature, DO, pH, turbidity, total suspended solids (TSS), nitrogen, and phosphorous. To get a better understanding of the daily DO concentrations, a diel DO analysis was conducted from September 9 through 11 of 2003. These samples were taken at the end of the summer season when the lowest DO concentrations are expected to be found due to a combination of high water temperatures (lower solubility of oxygen) and low flows. DO concentrations and temperatures were evaluated over five-minute intervals for the two-day period.

Toxicity testing was also conducted for water samples collected from the Stroubles Creek. The testing compared the survival and reproduction rates or fathead minnows (Pimephales promelas) and water fleas (Ceriodaphnia dubia) in water collected from the impaired sites with an unimpaired water source. The test did not document any statistically significant effects associated with fathead minnows or water fleas reared in water from Stroubles Creek. After this analysis, toxicity was not viewed as an issue on the monitored sites.

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[4]Ibid 2

In general, the Stroubles Creek had poorer water quality than Toms Creek, please see Section 4.0 of the TMDL document for additional information. Several possible stressors were seen as causing or contributing to the benthic impairment on Stroubles Creek. The possible stressors were nutrients, sediment, and organic matter. However, after review of the benthic and water quality data it was determined that sediment was the most possible stressor. Therefore, the TMDL was developed to control sediment, the controls needed to address this problem will limit the amounts of nutrients and organic matter to Stroubles Creek.

The next step in developing these TMDLs was to determine the loadings of sediment (the stressor) to the monitored and reference segments. The Generalized Watershed Loading Functions (GWLF) model was selected as the means to determine loadings to the streams. The GWLF model provides the ability to simulate runoff, sediment, and nutrient loadings from watersheds given variable source areas (e.g., agricultural, forested, and developed land).[5] GWLF is a continuous simulation model that uses daily time steps for weather data and water balance calculations.[6] Calculations are made for sediment based on daily water balance totals that are summed to give monthly values. To equate the reference watershed with the monitored watershed, the reference watershed was increased in size to that of the impaired watershed in the model, the land uses were proportionally increased based on the percent land use distribution. Therefore, the land use breakdown in the reference watershed remained constant.

Local rainfall and temperature data were needed to simulate the hydrology. The Blacksburg weather station was used for temperature and precipitation data for the TMDL. Unfortunately, there was no stream flow data on either the reference or the impaired water. The model was not calibrated to hydrology. The GWLF model was based on land use with flow parameters based literature values associated with the user manual. The TMDL takes into account the future land uses by modeling the watershed as it is expected to develop. Table 1 documents the TMDL allocations to the stream.

Table 1 - Summarizes the Specific Elements of the TMDLs.

| Segment | Parameter | TMDL (lbs/yr) | WLA (lbs/yr) | LA (lbs/yr) | MOS (lbs/yr)* |
|---|---|---|---|---|---|
| Stroubles Creek | Sediment | 2,145 | 233 | 1,697 | 214 |

* Virginia includes an explicit MOS by reserving the 10 percent of total loading to the MOS.

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

[5]Ibid 2

[6]Ibid 2

## III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing an aquatic life use (benthic) impairment TMDL for Stroubles Creek. EPA is therefore approving this TMDL. EPA's approval is outlined according to the regulatory requirements listed below.

*1) The TMDL is designed to meet the applicable water quality standards.*

Stroubles Creek was listed as impaired due to a degradation of the benthic macroinvertebrate community. As mentioned above, benthic assessments inform the biologist of an impairment, but they are unable to identify a stressor. Therefore, ambient water quality and toxicity data were reviewed to determine a possible stressor. Previous biological monitoring data was also re-evaluated to determine the likely stressors based on the biological assemblage in Stroubles Creek. Virginia has indicated that excessive levels of sediment have caused the degradation of the benthic communities on Stroubles Creek. The Commonwealth does not have numeric standards for sediment at this time. Therefore, the loading obtained from the reference watershed was used as the TMDL endpoint for Stroubles Creek. Its believed that if this loadings is obtained, the impairment to the benthic community will be relieved.

The GWLF model was used to determine the loading rates of sediment to the stream from all point and nonpoint sources. The TMDL modelers determined the sediment loading rates within each watershed. Data used in the model was obtained on a wide array of items, including farm practices in the area, the amount and concentration of farm animals, point sources in the watershed, land uses, weather, stream geometry, etc..

The GWLF model provides the ability to simulate runoff, sediment, and nutrient loadings from watersheds given variable source areas (e.g., agricultural, forested, and developed land).[7] GWLF is a continuous simulation model that uses daily time steps for weather data and water balance calculations.[8] To equate the reference watershed with the monitored watershed, the reference watershed was increased in size in the model. Each land-use was increased in equal proportion, insuring that the land use breakdown in the reference watershed remained constant. Local rainfall and temperature data were needed to simulate the hydrology in the model. In the GWLF model, the nonpoint source load calculation is affected by terrain conditions, such as the amount of agricultural land, land slope, soil erodibility, farming practices used in the area, and background concentrations of nutrients in soil and groundwater. Parameters within the model account for these conditions and practices and were based

[7]Ibid 2

[8]Ibid 2

upon the values called for in the GWLF users manual. Since there were no flow gages in the Stroubles Creek or Toms Creek watersheds, the hydrology component of the model was not calibrated to observed data.

EPA believes that using GWLF to model and allocate the sediment loadings to Stroubles Creek will ensure the attainment of Stroubles Creek's designated uses and water quality standards.

*2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.*

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of nutrients and sediment to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found in Table 1 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

Virginia has stated that there are ten regulated point sources discharging to Stroubles Creek. Three of the ten facilities are municipal separate storm sewer systems (MS4s), these systems are dedicated to the collection and discharge of stormwater. The remaining discharges are traditional NPDES permitted facilities. For the non-stormwater sources the WLA can be determined by multiplying the permitted flow by the permitted pollutant concentration. The WLAs for MS4 facilities were calculated as half of the modeled sediment from impervious land uses within the MS4 permit areas. The MS4 loads from the three permitted sources were combined into one lumped WLA since there was overlap in these areas.

EPA regulations require that an approvable TMDL include individual waste load allocations (WLAs) for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2a - TSS WLAs for Stroubles Creek

| Facility Name | Permit Number | Existing Load (t/yr) | Allocated Load (t/yr) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Litton Systems Inc. | VAR050441 | 2.7 | 2.7 |
| Virginia Tech - Central Heating Pit | VAR050508 | 0.46 | 0.46 |
| Virginia Tech - Dairy Science Center | VAR10042 | 2.37 | 2.37 |
| Virginia Tech - Campus | VAR10267 | 15.43 | 15.43 |
| Hawthorne Ridge Town Houses | VAR10275 | 0.77 | 0.77 |
| Carriage Court II | VAR10282 | 0.54 | 0.54 |
| Virginia Tech - Dairy Science Center | VPG120011 | 0.0 | 0.0 |
| Town of Blacksburg | VAR040019 | 455 | 210.88 |
| Virginia Tech | VAR040049 | | |
| Virginia Department of Transportation | VAR040016 | | |

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), load allocations (LAs) are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the GWLF model to represent the impaired watershed. The GWLF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint source loadings, and receiving water quality. GWLF uses precipitation data for continuous and storm event simulation to determine total loading to the impaired segments from the various land uses within the watershed.

Table 3 - LA for Sediment for Stroubles Creek

| Source Category | Existing Load | Proposed Load | Percent Reduction |
|---|---|---|---|
| Agriculture | 3,772 | 803 | 79 |
| Forest | 101 | 101 | 0 |
| Urban | 566 | 289 | 49 |
| Channel Erosion | 1,845 | 376 | 79 |

*3) The TMDL considers the impacts of background pollution.*

The reference watershed approach inherently considers the impact of background pollutants by considering the sediment load from all land uses, including forested lands, within the impaired and reference watersheds. The TMDL is developed to attain the loading seen in the reference watershed which has a load from natural sources.

*4) The TMDL considers critical environmental conditions.*

According to EPA's regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Stroubles Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[9]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

The GWLF model was run over a multi-year period to insure that it accounted for a wide range of climatic conditions. The allocations developed in the TMDL will therefore insure that the criteria is attained over a wide range of environmental conditions.

*5) The TMDL considers seasonal environmental variations.*

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. Pollutant loadings also change during the year as vegetation grows and sediment is less susceptible to runoff. Consistent with our discussion regarding critical conditions, the GWLF model and TMDL analysis effectively considered seasonal environmental variations through the use of observed weather data over an extended period of time and modifying the soil loss equations based on the time of the year.

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[9]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

*6) The TMDL includes a margin of safety.*

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia includes an explicit MOS by allocating 10 percent of the total TMDL loading to the MOS.

*7) There is a reasonable assurance that the TMDL can be met.*

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program.

The TMDL in its current form is designed to meet the applicable water quality standards. The Commonwealth intends to implement this TMDL through best management practices (BMPs). The implementation of these practices will occur in stages. This will allow the Commonwealth to monitor the benefits of the BMPs and determine which practices have the greatest impacts on water quality. It will also provide a mechanism for developing public support and checking the accuracy of the model.

*8) The TMDL has been subject to public participation.*

The first public meeting was held on October 17, 2002 in the Squires Student Center on the campus of Virginia Tech. Approximately 60 people attended the initial meeting. On October 9, 2003 the second public meeting was held. The second meeting was in the Donaldson Brown Hotel on the campus of Virginia Tech. Approximately 40 people attended this final meeting. All of the meetings and their associated comment periods were noticed in the Virginia Register.